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Geometry and emplacement of basaltic feeder dykes

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Dyke intrusion is known to be a complex process that usually ends in the formation of an arrested dyke. However, when the stress conditions are favourable the dyke propagates through the crust to the surface and issues magma. The dykes that connect the magma chamber with the surface are called feeder dykes. Feeder dykes are rarely observed volcanotectonic structures since they are usually covered by their own products. For this reason, outcrops are scarce and usually restricted to cliffs, ravines, and man-made outcrops.

Feeder dykes from Tenerife (Canary Islands, Spain) and Iceland have been studied in order to describe their geometric characteristics and their interaction with discontinuities in the host rock, such as tension fractures, faults, and contacts between layers. Although there have been many recent eruptions in both islands, only eleven basaltic feeder dykes have been identified: eight in Tenerife and three in Iceland. They are all well preserved and with well-exposed connections between the dyke and the associated eruptive fissure and/or deposits. Generally, the feeder dykes in Tenerife and Iceland are similar as regards geometry and emplacement mechanisms. There are, however, some differences, the main ones being that, in comparison with the feeders in Tenerife, the feeders in Iceland are longer and produce longer eruptive fissures and greater eruption rates. The rate of spreading (extension) is also higher in Iceland than in Tenerife.

As regards the detailed geometry and emplacement mechanism of the feeder dykes, our field data indicate as follows: (1) the overall dyke geometry is sheet-like, although plugs and sills may formed under cinder cones at high eruptive rates; (2) all the dykes and the associated eruptive fissures are segmented; (3) in the uppermost 2-3 m below the surface, the dykes are commonly with elongated empty holes in the centre (parallel with the dyke dip) with solidified magma drops on the hole walls; (4) vesicles in the dyke rock increase in size and frequency close to the surface; (5) some dykes propagate through existing faults and, where the plane of the fault is oblique to the plane of the dyke, the dyke forms small, igneous fingers that propagate within the fault plane; and (6) when a dyke and a fault intersect, the eruptive style may be affected; in particular, at the surface, the volumetric magma flow rate may be highest at such intersections.

These results, particularly items 5 and 6, suggest that for forecasting, and monitoring an actual, fissure eruption, it is important to identify all faults in volcanic areas since they may have strong effects on the feeder-dyke path and the eruptive style once the dyke has reached the surface. Modelling the mechanical interaction between feeder dykes and faults should help us understand the conditions that allow magma to flow into, and occasionally up along, fault planes. Further field and modelling studies will address the stress conditions which favour the propagation of feeder dykes and eruptive fissures close to and at the surface.